CLAIMS

We claim:

1. A device for measuring the flow rate of a fluid in a flow channel, comprising:

means for creating localized compositional variations in the fluid along the flow axis;

means for subsequently detecting the compositional variation at a point downstream from its point of creation; and

means for measuring flight time, wherein said device is capable of measuring flow rates from less than about 1 nL/min to greater than about 10 μL/min at pressures as great as 2,000 psi.

2. A device of claim 1, wherein said means for producing localized composition variations comprises, in combination:

spaced-apart electrodes disposed along the fluid flow axis in the flow channel and means for applying a voltage pulse to said electrodes.

3. The device of claim 2, wherein said spaced apart electrodes comprise a pair of spaced apart electrodes.

4. The device of claim 1, wherein compositional variation includes changes in pH.

5. The device of claim 1, wherein said means for detecting is disposed in a flight tube attached to the

fluid exit of the flow channel and concentric with the flow channel, and wherein the internal diameter of the flight tube is less than that of the flow channel.

6. The device of claim 5, wherein the flight tube has a length about 4 times greater that its diameter.

7. The device of claim 1, wherein said means for detecting is a conductivity sensor.

8. The device of claim 1, wherein the electrodes include stainless steel, platinum, palladium, or gold.

9. The device of claim 1, wherein the electrodes comprise an outer body fabricated from a microporous material and an inner metal electrode.

10. The device of claim 9, wherein the microporous material is a porous glass or an ionomer material.

11. The device of claim 10, wherein the ionomer material is a cation-selective perfluorosulfonate ionomer.

12. A device for measuring fluid flow rates, comprising:

a substrate fabricated to define a microchannel system disposed thereon, the microchannel system, in part, comprising:

a flow channel;

a pair of spaced-apart electrodes disposed along the fluid flow axis in the flow channel;

means for applying a voltage pulse to said pair of electrodes, to produce a variation in the composition of the fluid;

means for detecting the compositional variation; and

means for measuring flight time.

13. The device of claim 12, wherein the electrodes comprise an outer body fabricated from a microporous material and an inner metal electrode.

14. The device of claim 13, wherein the microporous material is a porous glass or an ionomer material.

15. The device of claim 14, wherein the ion selective material is a cation-selective perfluorosulfonate ionomer.

16. The device of claim 12, wherein said device is capable of measuring fluid flow rates at pressures as great as 2,000 psi.

17. A method for measuring fluid flow rates, comprising:

providing a fluid flow channel;

flowing fluid through the flow channel;

producing a compositional variation in the fluid;

detecting the compositional variation; and

measuring the flight time of the variation.

18. The method of claim 16, wherein said step of

producing comprises applying a voltage of about 110 V for about 1 ms.

19. An electrode for electrokinetic systems, comprising:

an outer body fabricated from a microporous material and an inner metal electrode.

20. The electrode of claim 19, wherein the microporous material is a porous glass or an ionomer material.

21. The device of claim 20, wherein the ion selective material is a cation-selective perfluorosulfonate ionomer.

22. The device of claim 2, wherein said means for producing comprises at least three spaced-apart electrodes disposed along the fluid flow axis in the flow channel.

23. The device of claim 22, wherein said three electrodes are disposed in a proportioned channel having a length to hydrodynamic diameter ratio greater than 10.

24. The device of claim 22, wherein said three electrodes are spaced at unequal distances from each other.

25. The device of claim 24, wherein the spacing distance is determined by the flow rate range to be measured.

26. The device of claim 22, wherein the electrodes

comprise an adhesion layer of tantalum and a metal layer disposed thereon.

27. The device of claim 23, wherein the metal layer is platinum.

28. The device of claim 22, wherein the electrodes comprise an outer body fabricated from a microporous material and an inner metal electrode.

29. The device of claim 28, wherein the microporous material is a porous glass or an ionomer material.

30. The device of claim 29, wherein the ionomer material is a cation-selective perfluorosulfonate ionomer.

31. A device for measuring fluid flow rates, comprising:

a substrate fabricated to define a microchannel system disposed thereon, the microchannel system, in part, comprising:

a flow channel;

at least three spaced-apart electrodes disposed along the fluid flow axis in the flow channel;

means for applying a voltage pulse to pairs of electrodes, to produce a variation in the composition of the fluid;

means for detecting the compositional variation; and

means for measuring flight time.

32. The device of claim 31, wherein said three spaced-apart electrodes are disposed in a channel having a length to hydrodynamic diameter ratio greater than 10.

33. The device of claim 31, wherein said three spaced-apart electrodes are spaced at unequal distances from each other.

34. The device of claim 32, wherein the spacing distance is determined by the flow rate range to be measured.

35. The device of claim 31, wherein said means for detecting is a conductivity sensor.

36. The device of claim 31, wherein the electrodes comprise an adhesion layer of tantalum and a metal layer disposed thereon.

37. The device of claim 36, wherein the metal layer is platinum.

38. The device of claim 32, wherein the electrodes comprise an outer body fabricated from a microporous material and an inner metal electrode.

39. The device of claim 38, wherein the microporous material is a porous glass or an ionomer material.

40. The device of claim 39, wherein the ionomer material is a cation-selective perfluorosulfonate ionomer.